

Original**Modified high perimandibular approach for vertical mandibular ramus and coronoid fractures**

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J. Natl. Def. Med. Coll. (2021) 46 (3) : 93–99

Abstract: Mandibular ramus and coronoid fractures are extremely rare. It is not clear whether open reduction and internal fixation (ORIF) or non-invasive treatments should be adopted for mandibular ramus and coronoid fractures. The present report provides a summary of five cases of vertical mandibular ramus and coronoid fractures with good outcomes following a modified high perimandibular approach, in which the invasive treatment of the masseter muscle was replaced by protective separation of the fascia and muscle fibers only, providing easy access to the mandibular ramus and coronoid fracture sites. Since 2016, five patients (three women, two men; age range, 49-77 years) with vertical mandibular ramus or coronoid fractures were treated by the modified high perimandibular approach using appropriate titanium plates and screws. All cases achieved comfortable surgical accessibility to the fractures without transection of the masseter muscle using the modified high perimandibular approach. Postoperative images showed successful reduction and osteosynthesis in all cases. There were no cases of damage to the marginal branch of the facial nerve. ORIF of vertical mandibular ramus or coronoid fractures using the modified high perimandibular approach seems to minimize the risk of postoperative facial nerve palsy and trismus, and it offers comfortable surgical accessibility to the fracture line.

Key words: high perimandibular approach / vertical mandibular ramus fractures / coronoid fractures

Introduction

The incidence of mandibular fractures is high in maxillofacial fractures; they are most commonly observed in the parasymphysis, angle, and condylar process regions. On the other hand, mandibular ramus and coronoid fractures are extremely rare.

The incidence of mandibular ramus and coronoid fractures has been reported in various studies. Vyas et al¹⁾ observed a mandibular ramus fracture incidence of 1.98% and a coronoid fracture incidence of 2.64%. According to Dongas et al²⁾, the mandibular ramus fracture incidence was 1.8%, and the coronoid fracture incidence

was 1.5%, and Bormann et al³⁾ reported incidences of 2% for mandibular ramus and 0.3% for coronoid process fractures.

It is not clear whether open reduction and internal fixation (ORIF) or non-invasive treatments should be adopted for mandibular ramus and coronoid fractures. A problem with selecting ORIF for mandibular ramus and coronoid fractures is the tendency to complicate the access to the fracture site, and the ideal approach in ORIF is yet unknown. For some time now, we have often used the high perimandibular approach for condylar fractures. The high perimandibular approach

is an approach proposed by Wilk et al., which overcomes the shortcomings without compromising the benefits of the widely used Risdon approach and the retromandibular approach for condylar fractures⁴. In the high perimandibular approach, the skin incision is placed immediately below the lower border of the mandible, preserving the marginal mandibular branch of the facial nerve by setting the transection of the platysma and masseter muscles above the marginal mandibular branch of the facial nerve⁴. However, temporary trismus has been reported after transection of the masseter muscle with the high perimandibular approach⁵. In order to avoid the masseter transection of the high perimandibular approach, the invasive treatment of the masseter muscle was replaced by transection of the fascia and split along the direction of the muscle fibers only, providing easy access to the mandibular ramus and coronoid fracture sites. We named this the modified high perimandibular approach and applied it to eight cases of condylar fractures⁶.

Based on our extensive literature search on PubMed, there were no reports of the high perimandibular approach for mandibular

ramus or coronoid fractures. The present report provides a summary of five cases with good outcomes in which the modified high perimandibular approach was used for vertical mandibular ramus and coronoid fractures.

Materials and methods

Surgical technique

The modified high perimandibular approach was considered appropriate for the treatment of patients with vertical mandibular ramus and coronoid fractures. The interval between the time of fracture and surgery was 1-4 days. The surgical technique was performed under general anesthesia. A 3-cm skin incision was made 5 mm below the lower border of the mandible after local injection with a solution of 1% lidocaine and 1:100,000 epinephrine (Fig 1). Subcutaneous transection was performed superficial to the fascia of the platysma muscle, 2 - 3 cm above the lower border of the mandible (Fig 2). The fascia of the platysma muscle was then cut parallel to the lower border of the mandible. After the surgical identification of the masseter muscle (Fig 3), the transection of the masseter fascia was performed parallel to the running direction of the masseter muscle fibers. In the next step,



Figure 1. Location of the 3-cm skin incision 5 mm below the lower border of the mandible and facial artery.



Figure 2. Surgical skin incision and subcutaneous transection are performed superficial to the fascia of the platysma muscle.

the masseter muscle was split carefully using a thin surgical retractor to expose the fracture line toward the coronoid (Fig 4). Though transection of the masseter muscle is not intersecting to the skin incision with this approach, excellent exposure of the fracture line in both vertical mandibular ramus fractures and coronoid fractures is obtained. After reduction of the fractures, osteosynthesis was performed with a suitable titanium miniplate system (Depuy Synthes, Oberdorf, Switzerland) (Fig 5). If the occlusal check was satisfactory, the temporary intermaxillary fixation was removed at the end of the procedure. Accurate closure of the masseter muscle, masseter fascia, and platysma muscle was performed with resorbable sutures, and the skin was closed with non-resorbable sutures. Placement of a suction drain and rigid intermaxillary fixation were not performed in any of the cases.

Patients and fractures

Since 2016, a total of 5 patients with vertical mandibular ramus or coronoid fractures were treated by the modified high perimandibular approach using appropriate titanium plates and screws in our department. The patients were

three women and two men, aged 49 - 77 years. All patients had concomitant fractures at another site with occlusal derangement and trismus. Three patients had vertical mandibular ramus and mandibular body fractures, 1 patient had a coronoid fracture with panfacial fractures, and 1 patient had combined vertical mandibular ramus and coronoid fractures with panfacial fractures. After physical examination, all patients



Figure 4. The masseter muscle is split carefully using a thin surgical retractor to expose the fracture line toward the coronoid, and comfortable surgical accessibility with a straight angle is provided.

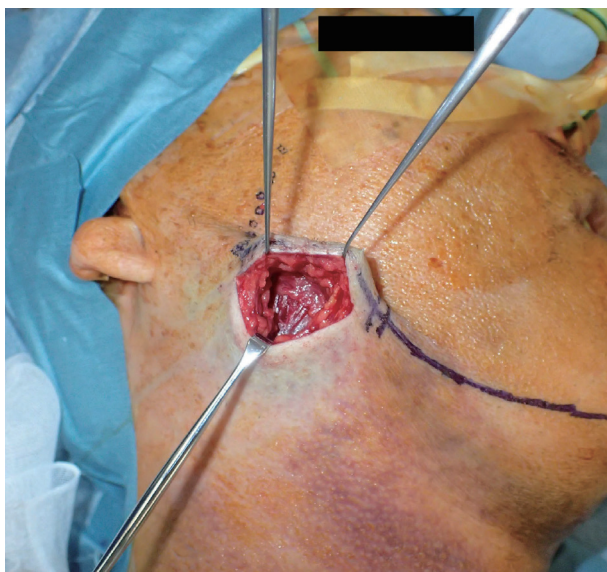


Figure 3. Masseter muscle exposure after platysma muscle incision.

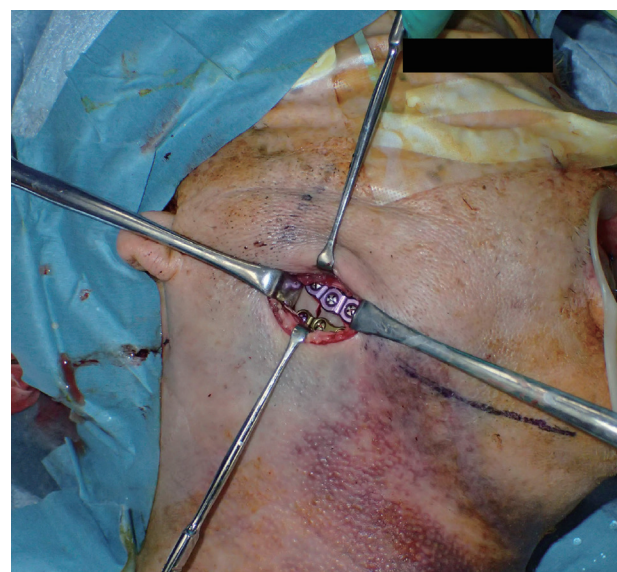


Figure 5. The fracture is reduced and fixed with a titanium miniplate system.

underwent preoperative computed tomography.

All patients had regular follow-up examinations including postoperative imaging for over 6 months postoperatively to evaluate: maximum interincisal mouth opening, dental occlusion, scar formation, damage to the marginal branch of the facial nerve, surgical site infection, fracture reduction, and osteosynthesis. The follow-up period ranged from 6 to 8 months. This retrospective study has been approved by Ethics Committee of The National Defense Medical College (approval No.4102).

Results

All cases achieved comfortable surgical accessibility to the fractures without transection of the masseter muscle using the modified high perimandibular approach. Postoperative images showed successful reduction and osteosynthesis in all cases (Fig 6). Postoperative maximum interincisal mouth opening was 35 - 38 mm at the end of 6 months, and postoperative dental occlusion was considered approximately identical to pre-injury occlusion in all cases. All patients were satisfied with the appearance of their scars (Fig 7), achieving excellent cosmetic outcomes. There were no cases of damage to

the marginal branch of the facial nerve. There were no surgical site infections in any cases. No failures of the titanium miniplate system including screw loosening were observed in any cases (Table 1).

Discussion

Mandibular fractures occur commonly following maxillofacial trauma, despite the fact that the mandible is the largest and strongest facial bone⁷⁾. However, the incidence of vertical mandibular ramus or coronoid fractures is extremely low compared with fractures of the condyle or parasymphysis. Coronoid fractures have the lowest incidence of mandibular fractures, with vertical ramus fractures having the second lowest³⁾. Borman et al. reported that the incidence of mandibular ramus fractures was 2%, followed by coronoid fractures at 0.3%³⁾. This low incidence may be related to the anatomical location of the ramus and coronoid, which are surrounded by the masseter muscle, medial pterygoid muscle, temporalis muscle, and malar bone.

Treatment of vertical mandibular ramus or coronoid fractures remains controversial in general. Kale et al⁸⁾ reported that ramus

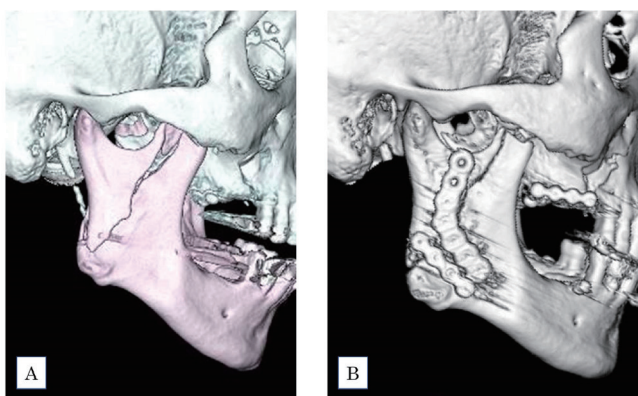


Figure 6. Combined vertical mandibular ramus and coronoid fractures before (A) and after (B) ORIF.



Figure 7. Scar 3 months after surgery.

fractures are conventionally treated by closed reduction because of the difficulty accessing these fractures, and also because these fractures seldom cause malocclusion. However, treatment by ORIF provides advantages, such as early return to function, easier maintenance of oral hygiene, improved nutrition, and reduced risk of airway compromise. Furthermore, the literature focused on management of coronoid fractures is very limited^{9, 10)}. An important aim in the management of coronoid fractures is to prevent ankylosis by early mobilization of the mandible¹¹⁾. Our basic strategy for achieving this in vertical mandibular ramus or coronoid fractures is open reduction and rigid internal fixation by a modified high perimandibular approach.

The original high perimandibular approach provided comfortable accessibility to condylar fractures, avoiding injury to the submandibular branch of the facial nerve⁴⁾. On the other hand, the original high perimandibular approach needed transection of the masseter muscle, which caused concern about the risk of trismus postoperatively⁵⁾. We improved the original high perimandibular approach to treat vertical mandibular ramus or coronoid fractures, calling it the modified high perimandibular approach, by requiring no transection of the masseter muscle, with the exception of the masseter fascia, to minimize the risk of postoperative trismus. As far as we are aware, this is the first report showing the usefulness of the high perimandibular approach for vertical mandibular

ramus or coronoid fractures.

Compared to the original high perimandibular approach, the new approach has two obvious advantages. The first advantage is no transection of the masseter muscle, compared with the necessity of transection in the original high perimandibular approach. The modified high perimandibular approach is considered to be less invasive than the other approaches represented by the submandibular approach and the retromandibular approach, including the original high perimandibular approach. Injury of the marginal branch of the facial nerve may occur during open reduction by the submandibular approach¹²⁾. The retromandibular approach is not widely performed because of the proximity of the operative field to the branch of the facial nerve, the retromandibular vein, and the parotid gland¹³⁾. In this report, no patients suffered any injuries of these tissues. The degree of postoperative trismus in all 5 cases was very limited, with sufficient improvement of mouth opening of more than 35 mm within 3 months after ORIF.

The second advantage is easy and adequate surgical accessibility. Vertical mandibular ramus or coronoid fractures run almost parallel to the masseter muscle; therefore, comfortable surgical accessibility to the fractures due to blunt transection of the masseter muscle using surgical retractors provides the second advantage. In the modified high perimandibular approach, the fracture line can be accessed with a straight angle; therefore, surgeons have

Table 1. Patient data and postoperative follow-up complications.

Age	Gender	Vertical mandibular ramus fractures	Coronoid fractures	Concomitant fractures	Maximum interincisal mouth opening	Occlusion	Scar formation	Damage to the facial nerve	Surgical site infection	Fracture reduction	Osteosynthesis
71	Female	Yes	No	Mandibular body	35mm	Normal	Cosmetic	No	No	Anatomic	Good
63	Female	Yes	No	Mandibular body	38mm	Normal	Cosmetic	No	No	Anatomic	Good
77	Male	Yes	Yes	Panfacial fractures	35mm	Normal	Cosmetic	No	No	Anatomic	Good
49	Male	Yes	No	Mandibular body	35mm	Normal	Cosmetic	No	No	Anatomic	Good
69	Female	No	Yes	Panfacial fractures	35mm	Normal	Cosmetic	No	No	Anatomic	Good

the advantage of precise control of anatomical reduction. All 5 cases treated by the modified high perimandibular approach had satisfactory anatomical reduction without any major complications and disadvantages.

Conclusion

The incidence of vertical mandibular ramus or coronoid fractures is very low. ORIF of vertical mandibular ramus or coronoid fractures using the modified high perimandibular approach seems to minimize the risk of postoperative facial nerve palsy and trismus, and it offers comfortable surgical accessibility to the fracture line. This surgical approach has been routinely performed in our department, and further accumulation of clinical data for detailed evaluation will continue.

Competing interests

Authors declare no conflict of interests for study.

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下顎枝縦骨折と筋突起骨折に対する modified high perimandibular approach

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防医大誌 (2021) 46 (3) : 93 - 99

要旨：下顎枝縦骨折と筋突起骨折は極めて稀である。下顎枝縦骨折と筋突起骨折に対して観血的整復固定術と保存的治療のどちらを行うべきか明らかではない。今回、われわれは下顎枝縦骨折と筋突起骨折5例に対して、咬筋への侵襲を筋膜切開と剥離のみに低減した modified high perimandibular approach を用いて骨折部位への容易な到達と良好な予後を獲得したので報告した。2016年以降、下顎枝縦骨折もしくは筋突起骨折骨折を認めた5名（男性2名，女性3名，49-77歳）に対して modified high perimandibular approach にてチタン製プレートとスクリューを用いて治療を行った。modified high perimandibular approach により全症例とも咬筋を切離することなく、骨折部位への容易な到達が可能であった。術後の画像検査により適切な骨接合術が行われたことを全症例で確認した。顔面神経下顎縁枝の損傷は全症例で認められなかった。下顎枝縦骨折と筋突起骨折に対する modified high perimandibular approach を用いた観血的整復固定術は、術後の顔面神経下顎縁枝損傷や開口障害のリスクを低減させ、骨折部位への容易な到達を可能にすると考えられた。

索引用語： high perimandibular approach / 下顎枝縦骨折 /
筋突起骨折